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What determines the long-run growth in Sub-Saharan Africa? Exploring the role of energy, trade openness and financial development in six countries*

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Abstract

This paper investigates the effect of energy efficiency, international trade and financial development on long-run income per capita growth of six Sub-Sahara African (SSA) countries, namely Botswana, Cameroon, Kenya, Senegal, South Africa and Togo. The Autoregressive Distributed Lag (ARDL) bound approach to cointegration is applied with (possible) structural breaks to examine both the short-term and long-term effects. Furthermore, generalized forecast error variance decomposition is applied to decompose the forecast variance of GDP per capita attributable to the selected independent variables. The long-term results show that trade openness and financial development affect positively and significantly income per capita in South Africa and Kenya, respectively. A compelling evidence of energy efficiency involvement in growth is found in Togo. The short-term estimations highlight the significant role of investment and energy in output process in virtually all the countries and the role of trade openness in South Africa and Togo. The findings also provide major policy implications for sustainable economic growth in SSA countries.

Keywords: Economic Growth; Energy; Trade openness; Financial development; Cointegration; Sub-Saharan Africa

JEL classification: C32; E44; F43; O47; Q43

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1 Introduction

A major current focus in policy management of developing countries is how to achieve a high sustainable economic growth. The importance of growth has been demonstrated and is considered as not sufficient but necessary in reducing poverty and improving the well-being of the population in developing countries (Fagnart and Hamaide, 2012; Hugon, 2006). For African countries, especially Sub-Sahara African (SSA) countries, sustainable growth is as well the main goal of policymakers. During the last decade, most African countries have experienced a revival in economic performance due to a growth rate close to 6% and an increase in per capita income by 30% (Jacquemot, 2013). This improvement follows a period of poor economic performances recorded in the continent. During the 80s, the real per capita income growth had been negative and then reached from -2.2% to 1.2% in the 1990s (Basu et al., 2000). Ghura and Hadjimichael (1996) stated that the unsatisfactory growth rates of SSA countries in the 80s in comparison to other developing countries were due to lower commodity prices, deteriorating terms of trade, adverse weather conditions, rapid population growth, political and economic instability. The implementation of structural adjustment program in most countries, although socially consequences remain debatable, helped lay down the base of successful business environment. Thus, between 2000 and 2012, African continent recorded average economic growth rate around of 5.1% (Hugon, 2013), owing to 5.6% for SSA and 4.5% for the North of the continent (AfDB, 2013). With an annual population growth above 2%, the poverty reduction assumes that this performance should be sustained in the long-term (AfDB, 2013). For this purpose, a basic issue is to understand the determinants of long-run economic growth in these countries.

In economic literature, the failures of countries to converge in per capita income and the determinants of economic growth have been extensively studied. One of the best known growth theoretical models is the neoclassical growth model developed by Solow (1956). This model predicts that in the steady state the level of per capita output is determined by exogenous factors i.e. the rate of population growth and the saving rate. Then, the different values of these factors across countries explain different steady state levels experienced by each country. Furthermore, Solow (1957) explains the long-term output growth by technical progress. He found that 87.5% of US income growth per worker during the period 1909 to 1949 is due to technical progress. Mankiw et al. (1990) found the effect of saving and population growth over evaluated and extended the Solow (1956) model by incorporating human capital accumulation to physical capital. Their findings certainly reduced the proportion of Solow residual, but a large part of growth determinants remains unknown. For Rao (2007), the Solow residual is more a measure of our ignorance than a true value of technical progress.

Alternative growth theories have attempted to identify endogenous factors that influence the Solow tech-

nological progress. Romer (1986) and Lucas (1993) showed that technological change is endogenously determined by accumulation of knowledge and human capital, which are assumed as crucial determinants of economic growth. Based on endogenous growth theory, numerous factors have been identified as determinant to technological progress. Jones (1995) in his review, refers to Grossman and Helpman (1991a,b) who cited no less than 10 potential determinants of long-run growth. For example, he mentions the rate of investment in physical and human capital, the export share, the orientation of local policies, the strength of property rights, the government spending, population growth and regulatory pressure. Although endogenous growth theories are useful, they suffer from few limitations. Kumar and Pacheco (2012) pointed out that endogenous growth equations are intrinsically difficult to estimate and when estimating it is necessary to use cross-section dimension. Moreover, these theoretical models do not use more than one or two variables. Time series data are suitable in examining the long-term of growth determinants of each country. One of the principal assumptions of endogenous growth theory is that a change in the structure of some variables due to public policies has a permanent effect on economic growth. However, empirical evidence of Jones (1995) on times series did not support this hypothesis. Parente (2001) and Rao (2007) suggested that a modified version of Solow exogenous growth model is more appropriate to account for change in production level over time.

Hence, this study uses an extended Solow Cobb-Douglas production function to investigate what determine SSA[1] long-term growth with a particular attention to energy efficiency, international trade and financial development. Because there is an urgent need of sustainable development, this study focuses on factors that are relevant for this region. Actually, there is a need to expand access to energy for consumption and production process due to a lack access in SSA. According to United Nations Development programme (UNDP), 69 percent of the region's population have lack access to energy live in 2011, and 78 percent of people who do, use traditional biomass. However, the development of energy sector differs from countries. For example, the World Bank reported that 85.4% of South Africa population had access to electricity in 2012, while it had been 23% in Kenya and 56.5% in Senegal. Then, this paper agrees with Brew-Hammond (2010) that energy is an essential input for socio-economic development and examines the effect of a gain in energy efficiency on long-run growth. Furthermore, SSA has a low integration rate to international trade and a low degree of financial development. Its share in world trade is less than 3% and is dominated by export of a narrow range of primary products[2]. The financial sector is underdeveloped and bank-centered. A small range of the population has a bank account (34% of adults in 2014 according to World Bank) and an access to formal financial services. The inclusion in investment and production process is as well limited.

[1]The study focuses on six SSA countries namely Botswana, Cameroon, Kenya, Senegal, South Africa and Togo.

[2]Early versions of this study considered the effect of international commodity price fluctuations besides energy, trade and financial development on the growth of SSA countries. The results were inconclusive and the study seemed to address two important issues simultaneously. Then future studies will focus on the problematic of international commodity prices and economic growth in SSA countries.

The domestic credit provided by financial sector in 2014 was estimated to 35.2% of GDP by the World Bank. Following this background, this study examines the contributions of energy efficiency, trade openness and financial development on economic growth in SSA countries, especially in Botswana, Cameroon, Kenya, Senegal, South Africa and Togo.

Few studies have been concerned with this issue in SSA countries and previous work has focused mainly on individual effect of these factors using different specifications and/or estimation methods leading to inconclusive results. Hossain and Mitra (2013) applied a panel causality and cointegration methods on 33 African country for the period 1974-2009 and found as for domestic investment and government spending, a long-run positive effect of trade openness on economic growth. In the same line, Kumar and Pacheco (2012) found for Kenya that trade openness is the key determinant in improving total factor productivity and consequently promoting long-run growth rate while Musila and Yiheyis (2015) established the opposite and asserted that a policy that induces trade openness in Kenya has an adverse effect on growth. Adu et al. (2013) investigated the long-run effect of financial development in Ghana and found a mixed effect depending on the indicator used to proxy financial development. The credit to the private sector and total domestic credit led to growth while broad money stock to GDP ratio did not. Rousseau and D'Onofrio (2013) used time series method and data for 22 SSA countries over the period 1960 to 2009 to explore if financial development supports economic growth. They found evidence for a positive and unidirectional statistical link from finance, even proxied by narrow or broad money to output in 16 of the 22 SSA countries studied. Kumar et al. (2015) used an extended Cobb-Douglas framework and the ARDL bound cointegration method to investigate the role of energy, trade and financial development in explaining the long-run growth in South Africa. They found in the long-run positive elasticity coefficients associated with energy and trade openness and a negative effect of financial development on economic growth.

This study contributes to the literature on growth determinants in three main ways: First, the use of appropriate growth specification as suggested by Rao (2007) on time series analysis might enable consistent results and deal with country heterogeneity; Second, the focus on economically important factors for SSA countries which have not been sufficiently studied; Finally the study extends that of Kumar et al. (2015) (1) by considering the efficiency aspect of energy use and a composite financial indicator which captures a broad information of financial development and fixes the inconsistencies observed in Adu et al. (2013), and (2) by expanding the study to five more SSA countries besides South Africa.

The remainder of this paper is structured as follows: Section 2 introduces our econometric specification and methods, Section 3 presents the empirical results while Section 4 discusses these results, and Section 5 concludes the study.

2 Model specification and Methods

2.1 Model specification

The paper assumes an extended Cobb-Douglas production function as follow:

$$Y_t = A_0 e^{[g_1 t + g_2 Z_t]} K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where Y is the real production, K the stock of physical capital, L the labour force, A_0 an index of initial stock of knowledge which is assumed to growth at rate g_1 function of unknown trended variables proxied with time t and at rate g_2 function of a vector of promoting shift variables Z, $\alpha < 1$.

Suppose that labour rise at exogenous rate of population growth n according to the following function:

$$L = L_0 e^{nt} \tag{2}$$

with L_0 the initial stock of labour force.

Let s and δ be respectively the fraction of income invested in physical capital and the rate of depreciation of physical capital. Then, capital accumulated function can be expressed as follow:

$$\frac{dK_t}{t} = sY_t - \delta K_t \tag{3}$$

Next, let y_t and k_t be the output and physical capital per unit of labour. Rewriting the production equation (1) and capital accumulation equation (3), we have:

$$y_t = A_0 e^{[g_1 t + g_2 Z_t]} k_t^{\alpha} \tag{4}$$

and

$$\frac{dk_t}{dt} = sy_t - (\delta + n)k_t \tag{5}$$

According to exogenous growth theory, in the steady state (in long-term), the level of physical capital per worker is constant. Thus, setting equation (5) to zero, the result gives:

$$k_t = \frac{sy_t}{\delta + n} \tag{6}$$

Substituting equation (6) in (4) and considering natural logarithms gives:

$$lny_t = lnA_0 + g_1 t + g_2 Z_t + \alpha ln(sy_t) - \alpha ln(\delta + n) \tag{7}$$

Taking variables in their first differences gives:

$$\Delta lny_t = g_1 + g_2 \Delta Z_t + \alpha \Delta ln(sy_t) \tag{8}$$

Some features of these specifications are noticeable. The equation (8) is the short-term dynamic equation of the rate of change of output and the equation (7) is the long-run relationship of the production function in the levels of the variables. These equations are useful to estimate the effect of some growth promoting variables expressed in vector Z. This study investigates the effect of energy efficiency, trade openness and financial development on production.

2.1.1 Energy efficiency

Growth theories have paid only small or no attention to the role of energy in promoting economic growth (Stern and Cleveland, 2004). Thus, the authors mentioned the virtual absence of theoretical and empirical studies that examine the role of energy in growth process, highlighting the involvement of thermodynamics in production. It is Georgescu-Roegen (1971) who introduced the laws of thermodynamics in economics. According to the first law (law of matter conservation), matter is neither lost nor created in the production process or any transformation process. And according to the second law (entropy law), processing material involves an irreversible process of energy available to an unavailable energy (Smulders, 1995). For Stern and Cleveland (2004), the second law implies that a minimum amount of energy is required to perform any transformation process. Then, energy is an essential factor to take into account in the production process. van Zon and Yetkiner (2003) extended the model of Romer (1990) by including energy consumption, which is considered as an intermediate factor of production and energy efficiency as a technological advance in the production function. Their results show that the efficiency can be improved through research and that any increase in energy prices, which would correspond to a high cost of intermediate factor, could have an adverse effect on production. This study contributes to fill the gap in empirical literature by examining the effect of energy efficiency, considered as an advance in technological process on economic growth.

2.1.2 Trade openness

International trade could affect positively economic growth by generating competitiveness in production process. According to Grossman and Helpman (1991c) technological progress results from profit maximization of entrepreneurs and the productivity of their employees depends on the state of scientific and industry know-how in the country, state of know-how which is related to the number of contacts that local agents have with counterparts in international community. For the authors, this number of contacts increases with commercial exchange. Thus, foreign trade of goods promotes exchange of ideas and then technological progress. Romer (1990) considers technological progress as the product of rational agents who are encouraged by the market to maximize their profit. Invest in technology is equivalent to support a fixed cost, which would require a huge market. Foreign trade can promote technological progress by providing a huge market, generate positive externalities for others countries and lead ultimately to faster growth. Empirically, prior studies have linked openness and the rate of growth. Sachs et al. (1995) found that open economies experienced faster growth in real GDP per capita over the period 1970-1989. Frankel and Romer (1999) handled trade potential endogeneity by constructing an instrument for international trade based on geographic characteristics. Their estimations across a panel of 150 countries showed that increasing the ratio of trade to GDP by one percentage point raises income per person by between one-half and two percent. More recently, Yanikkaya (2003) studied a panel of hundred countries and found that countries with higher trade shares are likely to grow faster than other countries. Dowrick and Golley (2004) tested the benefits of trade for growth across countries and over time and showed that trade openness benefits is accrued mostly to the richer economies and little to the less developed economies. They supported the finding of Sachs and Warner (1997) that specialization in primary exports is bad for growth. In their studies on the determinants of growth in Pakistan, Shahbaz et al. (2008) found a negative effect of international trade on growth while Shahbaz (2012) found a positive impact. Shahbaz et al. (2008) explained their finding by the low rate of Pakistan integration in world trade at this time. Chang and Mendy (2012) examined the effects of trade policies on economic growth in 36 African countries and found that trade openness is positively related to economic growth significantly.

2.1.3 Financial development[3]

The existence of costs for access to information and transaction has motivated the establishment of a financial market with a primary role of mobilizing and allocating financial resources among different agents in capacity

[3]Ncube (2007) reported that there remains an inconclusive debate in the literature about the appropriate financial system. Stiglitz (1985), Levine (2002) and Chakraborty and Ray (2006) suggested a bank-based financial system while Rajan (1992) and Weinstein and Yafeh (1998) supported the market-based financial system. Since SSA financial sector is dominated by the banking sector and in order to overcome the no readily availability of financial indicators (1980-2011), this study focuses on the bank-based sector and uses standard financial deepening indicators to evaluate the effect of financial development on income per capita.

and/or needing a funding. For Schumpeter (1974) the efficient functioning of banks encourages technological innovation by identifying and funding investors who are most likely to produce in innovative way. In economic literature, the debate on the effect of financial structural on growth was actually initiated by the comparative work of Goldsmith (1969) between the financial and macroeconomic statistics of some countries. For Levine (1997), a financial market that fulfils his duties, which are (i) facilitate the trading, diversifying and pooling risk, (ii) allocate resources, (iii) exert corporate control, (iv) mobilize savings and (v) facilitate the exchange of goods and services, promotes capital accumulation and technological innovation, will have in term a positive effect on growth. Thus, financial development would be a determinant in promoting economic growth in the sense that it would increase savings and then capital accumulation. Numerous empirical investigations have supported this assumption. For instance, Zhang et al. (2012) found that financial development is positively associated with growth in China. Likewise, Thangavelu et al. (2004) and Ang (2008) showed that the development of financial market leads to higher output growth of the Australian and Malaysian economies, respectively. Shan and Morris (2002) also validated these findings by investigated quarterly data from OECD[4] countries and China. Shahbaz et al. (2008) defining domestic credit to private sector as financial development, found that it is positively associated to growth in Pakistan. Bittencourt (2012) examined the case of Latin American countries and found a positive effect of financial development on production. In contrast, Hsueh et al. (2013) and Kar et al. (2011) performed a bootstrap panel Granger causality analysis between financial development and economic growth among ten Asian countries and MENA[5] countries, respectively. They found no clear consensus and that the results are sensitive to the financial measurements as well specific to the countries.

As for SSA countries, Adeniyi et al. (2015) found evidence of threshold effects in Nigeria i.e. financial development initially matters little for growth but conditional on a level of the former being exceeded some positive growth influence hits the surface. Ghirmay (2004) empirical investigation in 13 SSA countries showed that financial development plays a causal role on economic growth in the long-run in eight (Benin, Ethiopia, Ghana, Kenya, Malawi, Tanzania, Rwanda, and South Africa) of thirteen countries studied. Wolde-Rufael (2009) explored four measures of financial development in Kenya and found evidence of a two-way Granger causality between three out of the four indicators and economic growth, suggesting that financial development and economic growth are jointly determined. Rousseau and D'Onofrio (2013) found evidence from 22 SSA countries that financial development enable economic growth for about thirds of them. Ahmed and Mmolainyane (2014) examined the role of financial integration in Botswana and did not find a direct robust and statistically significant association with growth. Adu et al. (2013) found a conflicting result of

[4]Organisation for Economic Co-operation and Development.
[5]Middle East and North African.

financial development effect on growth by using different financial indicators in Ghana. With regard to these contradictions, this study constructs a financial development index in order to cover a large amount of financial sector.

2.2 ARDL cointegration approach

The current investigation involved determining some growth promoting factors in six SSA countries. Thus, the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. (2001) is performed to study the dynamic relationship between the production and the independent variables. This approach is suitable in this case as the long and short-run parameters are estimated simultaneously. Furthermore it avoids endogeneity problems and can be used whether the time series data have a unit root or not in their process. According to Narayan (2005), it is more appropriate for small samples than traditional cointegration methods, such as the test of Engle and Granger (1987) and the test of Johansen and Juselius (1990).

The empirical representation of ARDL bounds testing approach to cointegration is formulated following the aforementioned specifications (7) and (8). Moreover, as SSA countries might have faced external shocks such as socio-political crises, currency devaluation, financial or economic crises, etc., dummy variables DU_i ($i = 1, ..., k$; k is the number of breaks) are included to account for their effect on the production function. According to Pesaran et al. (2001) the asymptotic theory of the ARDL approach is not affected by the inclusion of such dummy variables. The dummy variables are defined by $DU_i = 1$ over the period $t > \tau_i$ (τ_i is the date that the shock occurred) and 0 elsewhere. The Bai-Perron sequential procedure is applied to the logarithm of the production per capita in order to check the number of breaks and the corresponding dates. Bai and Perron (1998) and Bai and Perron (2003) proposed a consistent procedure that test the null hypothesis of l changes in a series versus the alternative hypothesis of $l + 1$ changes. Since each country has its own experience, the break dates may vary with countries. Then, the ARDL representation can be written as follow:

$$\begin{aligned}\Delta lny_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{D_i} DU_i + \alpha_t t + \alpha_y lny_{t-1} + \alpha_I lnI_{t-1} + \alpha_E lnE_{t-1} + \alpha_T lnT_{t-1} + \alpha_F lnF_{t-1} \\ + \sum_{i=1}^{p_1} m_i \Delta lny_{t-i} + \sum_{i=0}^{p_2} v_i \Delta lnI_{t-i} + \sum_{i=0}^{p_3} g_i \Delta lnE_{t-i} + \sum_{i=0}^{p_4} h_i \Delta lnT_{t-i} + \sum_{i=0}^{p_5} j_i \Delta lnF_{t-i} + \epsilon_t \end{aligned} \quad (9)$$

where y is the income per capita (2005 $ US)[6], I is the fraction of income invested divided by the population,

[6]Following the assumption that labour rise at rate of population growth, income per capita and investment per capita were used as alternative to income per labour regressed on investment per labour to deal with the no readily availability of labour data.

E is energy efficiency, T is the ratio of openness to international trade, F is financial development, t is time trend variable, and ϵ is the regression error term.

The ARDL approach computes an F-statistic to compare with the critical bounds generated by Pesaran et al. (2001) to test for presence of cointegration between variables. The F-statistic is calculated following the null hypothesis $H_0 : \alpha_y = \alpha_I = \alpha_E = \alpha_T = \alpha_F = 0$ against alternative hypothesis of cointegration. The F-test does not have a standard distribution. Consequently, the upper and the lower critical bounds computed in Narayan (2005) were used as they are more appropriate for small sample size. If the F-statistic exceeds the upper bound, H_0 is rejected suggesting there is cointegration between variables, but if it falls below the lower bound, the null hypothesis cannot be rejected and if it is between both bounds, the test is uncertain. Before computing the F-test, it is necessary to choose the appropriate lag level $(p_1, p_2, p_3, p_4, p_5)$ for the ARDL model. This selection is done according to the Bayesian information criterion (BIC) and the Akaike's information criterion (AIC). Once a cointegration has been established, a long run relationship and an error correction model between the selected variables are estimated as formulated in equations below:

$$lny_t = \theta_0 + \theta_1 t + \theta_2 lnI_t + \theta_3 lnE_t + \theta_4 lnT_t + \theta_5 lnF_t + \mu_t \tag{10}$$

$$\begin{aligned}\Delta lny_t = {} & \beta_0 + \sum_{i=1}^{k} \beta_{1i} DU_i + \beta_2 t + \sum_{i=1}^{p_1} \beta_{3i} \Delta lny_{t-i} + \sum_{i=0}^{p_2} \beta_{4i} \Delta lnI_{t-i} + \sum_{i=0}^{p_3} \beta_{5i} \Delta lnE_{t-i} \\ & + \sum_{i=0}^{p_4} \beta_{6i} \Delta lnT_{t-i} + \sum_{i=0}^{p_5} \beta_{7i} \Delta lnF_{t-i} + \gamma ECT_{t-1} + \nu_t \end{aligned} \tag{11}$$

where the long run elasticities are defined as follow: $\theta_0 \equiv \alpha_0/\alpha_y$, $\theta_1 \equiv \alpha_t/\alpha_y$, $\theta_2 \equiv -\alpha_I/\alpha_y$, $\theta_3 \equiv -\alpha_E/\alpha_y$, $\theta_4 \equiv -\alpha_T/\alpha_y$ and $\theta_5 \equiv -\alpha_F/\alpha_y$,

ECT_{t-1} is the lagged residual term obtained from the long run relationship equation

$$ECT_t = lny_t - (\theta_0 + \theta_1 t + \theta_2 lnI_t + \theta_3 lnE_t + \theta_4 lnT_t + \theta_5 lnF_t)$$

γ is the speed of the adjustment process, and μ and ν are regression error terms.

2.3 Data

Based on the above econometric specifications, the study employes annual time series data from 1980 to 2011 to examine the impact of energy efficiency, international trade and financial development on the economic growth of six SSA countries namely, Botswana, Cameroon, Kenya, Senegal, South Africa and Togo. Energy efficiency is defined as the energy use per GDP, international trade as the sum of import and export in percentage of GDP, and a composite indicator of financial deepening is constructed to account for financial

development. This construction is carried out through principal component analysis following Gries et al. (2009) and Menyah et al. (2014) in order to capture a broad aspect of financial system development. Moreover this approach is suitable as it avoids multicollinearity and over-parameterization problems and the imbalanced representation of some dimensions of financial system due to the use of only one financial indicator. Since SSA financial sector is bank-centered, the financial development index is constructed using three standard financial indicators: the broad money to GDP (M2 to GDP), total domestic credit to the private sector to GDP, and total domestic credit provided by the banking sector to GDP. Data on gross domestic product, total population, imports, exports, energy use per GDP and financial indicators are collected from World development indicators (2013) of World Bank, and total investment is from World economic outlook (2013) of International Monetary Fund (IMF).

Table 1 summarizes the result of the principal component analysis. It reveals that the index contains at least 60% of the initial variance for each country, suggesting that sufficient financial sector information is considered.

Table 1: Results of principal component analysis

Country	Principal component (%)	Component matrix		
		Broad money	credit to private sector	credit provided by banking sector
Botswana	92.95	0.7071	0.7071	-
Cameroon	80.04	0.5609	0.6265	0.5412
Kenya	60.62	-0.0747	0.6993	0.7109
Senegal	64.29	-0.1288	0.6899	0.7123
South Africa	87.73	0.5337	0.5941	0.6018
Togo	77.68	0.5557	0.5980	0.5776

Note: The column Principal component represents the value of the initial eigenvalues as a percentage of the total variance the first principal component contains.

3 Results

3.1 Unit root tests

Time series analysis requires examining first the non-stationarity properties of the selected variables. Before applying unit root tests, the sequential procedure of Bai Perron is used to check if the series are independently and identically distributed with constant mean and finite variance against the alternative hypothesis of m time changes at unknown date. The findings validate the use of unit root tests that consider breaks in level and/or slope of the trend function. Consequently, the unit root tests with structural breaks proposed by Carrion-i Silvestre et al. (2009) and Harvey et al. (2013) (henceforth CKP and HLT, respectively) are

employed. The null hypothesis of these tests is that the series has a unit root process versus an alternative hypothesis of stationarity. These tests are suitable as they allow for an arbitrary number of changes in both the level and slope of the trend function under the null and alternative hypotheses. Perron (1989) showed that standard Dickey-Fuller type unit root test is not consistent when the alternative hypothesis is a stationary process with a break in the slope of the deterministic trend. Then, he proposed a method that allows for a break under both the null and alternative hypotheses. However, the Perron (1989) test supposes a break at known date. Zivot and Andrews (1992) dealt with this issue and developed a unit root test, commonly used in literature, that allow for a break at unknown date. Carrion-i Silvestre et al. (2009) noted the limit of this approach as it does not allow a break under the null hypothesis, but only under the alternative hypothesis. They proposed a method which does and adopted the quasi-generalized least squares detrending method supported by Elliot et al. (1996) and the M-class tests analyzed in Ng and Perron (2001). Harvey et al. (2013) recognized that Carrion-i Silvestre et al. (2009) approach is efficient both when breaks occur or not, but revealed that the power can be low for the magnitudes of trend breaks typically observed in practice. They suggested a method that takes this issue into account.

The results of CKP and HLT unit root tests are presented in Table 2. The tests are applied at the nominal asymptotic 5% significance level with the appropriate lag selected by the MAIC criterion. We find that the HLT tests which permit both a single break in trend (MDF1) and two breaks in trend (MDF2) reject the unit root null for investment per capita in Botswana and Cameroon, GDP per capita and trade openness in Senegal while only the MDF2 statistic rejects the null hypothesis for trade in Cameroon and financial development in Kenya and Togo. Nearly, the results of HLT tests are in accordance with the ADF statistic of the CKP test. In contrast, the M-class (MPT, MZA and MPT) and the feasible point optimal (PT) statistics of the CKP unit root tests support no rejection of the unit root null across all the series. Overall, the CKP and HLT unit root tests indicate that the series are I(0) or I(1) validating the use of ARDL cointegration testing approach. Furthermore, the Elliot et al. (1996) and Ng-Perron (2001) unit root tests are carried out on the first differences of the variables and the findings demonstrated that none of the variables is I(2)[7].

3.2 ARDL result

The ARDL bound test developed by Pesaran et al. (2001) is used to investigate the presence of long-term relationship between the selected variables. The test consists in determining first the optimal lag length $(p_1, p_2, p_3, p_4, p_5)$ to include in the auto-regressive model. The maximum lag is set to two, and the AIC and

[7]The Elliot et al. (1996) and the Ng and Perron (2001) tests are also applied to the variables in level. The results are not in line with those of CKP and HLT, supporting the use of appropriate tests that allow breaks under both null and alternative hypotheses.

Table 2: Results of unit root tests

Country	Variable	CKP test					HLT test	
		PT	MPT	ADF	MZA	MZT	MDF1	MDF2
Botswana	lny	16.12	17.12	-2.65	-9.35	-2.10	-2.54	-2.80
	lnI	12.27	11.68	-4.12*	-13.48	-2.55	-4.50*	-6.19*
	lnE	17.62	18.26	-2.41	-9.18	-1.82	-2.91	-3.46
	lnT	11.96	12.30	-2.77	-9.74	-2.16	-2.87	-3.13
	lnF	21.84	23.20	-2.21	-7.16	-1.88	-2.75	-3.37
Cameroon	lny	30.13	23.22	-2.64	-7.15	-1.88	-2.81	-3.83
	lnI	12.14	11.88	-4.81*	-13.85	-2.63	-4.83*	-5.48*
	lnE	30.62	24.14	-2.75	-6.86	-1.84	-2.68	-3.69
	lnT	12.31	11.76	-3.74*	-13.04	-2.55	-3.45	-4.65*
	lnF	24.99	25.42	-1.71	-6.04	-1.51	-2.14	-3.24
Kenya	lny	18.06	19.13	-2.10	-6.72	-1.83	-2.07	-2.69
	lnI	14.22	13.28	-3.49*	-12.55	-2.50	-2.44	-4.19
	lnE	10.45	11.03	-2.95	-10.60	-2.30	-2.85	-3.12
	lnT	16.25	17.17	-2.65	-9.66	-2.14	-2.92	-3.30
	lnF	18.40	18.89	-2.25	-8.44	-1.80	-2.70	-5.68*
Senegal	lny	13.36	12.01	-3.17	-13.12	-2.52	-4.10*	-5.09*
	lnI	13.59	13.98	-3.31	-11.71	-2.41	3.68	-4.30
	lnE	10.72	10.96	-3.60*	-12.48	-2.49	-3.08	-4.34
	lnT	16.30	14.66	-3.81*	-11.15	-2.36	-4.03*	-5.22*
	lnF	16.07	14.87	-3.16	-11.62	-2.22	-3.05	-5.05*
South Africa	lny	18.74	18.82	-2.50	-8.40	-2.05	-2.82	-3.40
	lnI	17.99	17.24	-2.50	-7.69	-1.96	-2.51	-3.72
	lnE	12.91	13.66	-3.33	-12.40	-2.39	-3.27	-4.44
	lnT	12.88	12.89	-3.68*	-12.93	-2.50	-3.28	-3.92
	lnF	9.88	10.26	-3.02	-11.81	-2.42	-3.41	-3.86
Togo	lny	16.91	17.07	-2.95	-9.68	-2.20	-2.84	-3.28
	lnI	20.50	17.88	-3.23	-9.24	-2.15	-3.78	-4.19
	lnE	13.30	13.54	-3.28	-11.64	-2.35	-3.72	-3.75
	lnT	12.62	13.17	-3.51*	-12.62	-2.49	-3.04	-3.82
	lnF	19.15	16.51	-1.50	-8.03	-1.94	-3.56	-6.35*

Note: * denotes rejection at 5% level of significance.

BIC criteria are used to identify the appropriate lag length. Moreover, dummy variables are considered in the ARDL model to take into account breaks occurred in SSA economies due to external shock. The time break τ_i is treated as unknown. Hence, the sequential procedure of Bai-Perron is applied to the GDP per capita series[8]. The results of the Bai-Perron test are presented in Table 3 and show the existence of one break in the growth process in Cameroon (1989), South Africa (2005) and Togo (1990), two breaks in Senegal (1989 and 2005), and no break in the case of Botswana and Kenya. All these breaks are considered in the ARDL F-test. The F-test results of the long-run relationship between income per capita, investment per capita, energy efficiency, trade openness and financial development for each country are presented in Table 3. The calculated F-statistics are compared to the critical bounds of Narayan (2005) for the test conclusion.

The results fail to reject the null hypothesis of no long run relationship for Botswana and Kenya, show the opposite for Cameroon and South Africa, and are inconclusive for Senegal and Togo as the F-stat fall between the lower and the upper bounds. The inclusion of dummy variables in the ARDL models is relevant in enhancing the results of the F-test. The F-stats are improved when the effect of the dummy variables is statistically significant. The best models are used in estimating the long-run elasticities between income per capita and the independent variables.

Table 4 summarizes the estimated long-run elasticities results. Excepting Cameroon and Kenya, the long run results are in accordance with the F-test. Indeed, no significant long-term elasticities are found for Botswana, Senegal and Cameroon whereas the F-test suggested the opposite for the latter. Moreover, a significant relationship between income per capita and independent variables is observed in Kenya, South Africa and Togo.

Table 3: The ARDL F-test cointegration results

Country	break date	BIC lag	F-stat	ECT_{t-1}	Dummy coefficient
Botswana	–	(1, 0, 0, 0, 0)	**2.43**	-0.257**	
Cameroon	–	(1, 0, 1, 1, 1)	4.25		
	1989	(1, 0, 1, 1, 0)	**7.43****	-0.196***	-0.078***
Kenya	–	(2, 0, 1, 0, 1)	**3.27**	-0.415***	
Senegal	–	(2, 0, 1, 0, 0)	1.90		
	1989; 2002	(1, 0, 0, 2, 2)	**3.64**	-0.236***	-0.042*; 0.042*
South Africa	–	(1, 1, 0, 1, 0)	**5.95****	-0.271***	
	2005	(1, 0, 0, 0, 0)	1.40		0.026
Togo	–	(1, 2, 2, 1, 2)	**3.52**	-0.451***	
	1990	(1, 2, 2, 1, 2)	3.18		-0.010

Note: The critical values are from Narayan (2005), case IV: unrestricted intercept and unrestricted trend, n=30 and k= 4; *, ** and *** represent 10%, 5% and 1% level of significance, respectively.

Thus, the findings show that investment per capita has a positive and significant effect on income growth

[8]Appendix A displays the graphical representation of real GDP per capita

in Kenya and South Africa. A one percent increase of per capita raises income per capita by 0.04% in Kenya and by 0.15% in South Africa. One of the main determinants of economic growth in Togo is energy efficiency. The absolute value of the coefficient associated to this variable is more than unity. The SSA countries have an output process which is highly dependent on fossil fuel. Moreover, the technologies used are not necessarily efficient in energy consumption, so that they face a high production cost, reducing their competitiveness. A gain of one unit in energy efficiency, which would represent a decline in the proportion of energy needed for a unit of production, leads to an increase of 1.87% of income per capita in Togo. Concerning the effect of international trade and financial development, the estimation gives respectively a positive effect on production in South Africa and conflicting results for Kenya and Togo.

We find that international trade promotes long-term growth in South Africa. A one percent increase of foreign trade ratio leads to 0.34% increase of income per capita. This result supports the views of Grossman and Helpman (1991c) and Romer (1990) that foreign trade affects positively economic activities by providing a wide market and leading to technical progress. Then the participation of South Africa to international trade generates positive externalities so that agents have incentive to invest in technology and physical accumulation due to the reduction of fixed costs. Financial development contributes to increase per capita income in Kenya (0.22) while the opposite effect occurs in Togo (-0.26). Following Levine (1997), the findings suggest that financial sector fulfils his function in Kenya by promoting capital accumulation and technological progress. Khalifa Al-Yousif (2002) notices two main channels through what financial development promotes economic growth. It affects growth by raising the efficiency of capital accumulation and by raising the saving rate and consequently investment. However, this positive effect of financial development is not observed in the case of Togo. Saxegaard (2006) and Nketcha Nana and Samson (2014) argue that in many African countries and particularly in some SSA countries, credit rationing encourage many banks to hold a large amounts of liquid assets. According to Tybout (1983) and McKinnon (1973), poor financial intermediation reduces the quality of capital accumulation and thus can be damaging to the development prospects of a country.

In order to check for the stability of the long-term elasticities, diagnostics test on the ARDL models are performed. These tests include the Lagrange multiplier test of residual serial correlation (χ^2_{sc}), the normality test based on the test of skewness and kurtosis of residuals (χ^2_n) and the ARCH test for heteroscedasticity (χ^2_{hc}). The diagnostics tests fail to reject the null hypotheses of no serial correlation, of normality and no heteroscedasticity for all the countries. Moreover, the CUSUM and CUSUMSQ figures are used to examine the stability condition of the parameters where a significant long term is established, namely for Kenya, South Africa and Togo. The statistic figures are presented in Appendix B. The stability condition is fulfilled if the CUSUM and the CUSUMSQ statistics fall inside the critical bounds of 5%. The tests show that the parameters in the model are stable over the period studied.

The estimation of an error correction model also validated the existence of a long run relationship in these countries as the error correction term (ECT) has the right sign, i.e. negative and is significant. The error correction term represents the speed of adjustment required to re-establish equilibrium in the short-term. A deviation from long-run growth due to an external shock is corrected by 41.5% over one year in Kenya and 27.1% in South Africa while 45.1% of the deviation is corrected within one year in Togo.

Table 4: Long-run estimates based on ARDL approach

Dependent variable = lny						
Variable	Botswana	Cameroon	Kenya	Senegal	South Africa	Togo
lnI	-0.062	0.026	0.044**	0.024	0.148***	-0.087
	(-0.953)	(0.301)	(2.47)	(0.281)	(5.973)	(-1.200)
lnE	-0.621	0.300	-0.121	0.477	0.103	-1.865***
	(-1.49)	(0.418)	(-0.215)	(0.739)	(0.573)	(-3.684)
lnT	-0.176	0.529	0.034	-0.149	0.341***	-0.051
	(-0.636)	(1.6)	(0.544)	(-0.635)	(3.306)	(-0.423)
lnF	-0.153	-0.045	0.221**	-0.219	-0.300	-0.259*
	(-1.302)	(-0.33)	(2.842)	(-0.673)	(-1.3)	(-2.079)
trend	-0.021	0.003	-0.008***	-0.004	-0.021***	-0.024***
	(-1.358)	(0.351)	(-3.081)	(-0.641)	(-3.127)	(-3.046)
constant	-12.984***	-3.385	-5.474	-5.267*	-5.883***	-18.705***
	(-4.582)	(-0.627)	(-1.457)	(-2.003)	(-3.593)	(-5.168)
Diagnostic tests						
Serial correlation $\chi^2_{sc}(1)$	1.353	4.472	0.239	2.752	1.067	0.979
	[0.245]	0.035]	[0.625]	[0.097]	[0.302]	[0.322]
Normality $\chi^2_n(2)$	2.915	0.878	0.244	1.073	1.052	0.456
	[0.233]	[0.645]	[0.885]	[0.585]	[0.591]	[0.796]
Heteroscedasticity $\chi^2_{hc}(1)$	0.007	0.185	0.322	0.023	0.684	0.515
	[0.932]	[0.667]	[0.571]	[0.880]	[0.408]	[0.473]

Note: *, ** and *** indicate significance level at 10%, 5% and 1%;
Student t-statistics are in parentheses and p-value are in brackets.

We also examine the short-term effect of investment per capita, energy efficiency, trade openness and financial development on production, so to regard the countries where a long-run relationship is not found. Table 5 shows the results of the estimated short-term model. We find that investment per capita and a gain in energy efficiency affect significantly and positively the variation of GDP per capita in the short-term. The results reveal also that energy is a crucial issue in SSA countries as an energy efficiency due to a decrease in energy cost, and less energy use per unit of GDP leads to more variation of production in the short-term than let the others factors like investment or trade. Trade openness is involved positively in production variation only in South Africa and Togo. Furthermore, the short-term result highlights the underdeveloped financial sector in SSA countries. We find no significant effect of financial development on the rate of change of income in the short-term.

Table 5: Short-run results

Dependent variable = $\Delta(lny)$						
Regressors	Botswana	Cameroon	Kenya	Senegal	South Africa	Togo
$\Delta(lnI)$	0.037***	-0.001	0.036**	0.040**	0.063***	0.038*
	(3.354)	(-0.055)	(2.758)	(2.165)	(4.497)	(2.002)
$\Delta(lnE)$	-0.287*	-0.865***	-0.596***	-0.297**	-0.025	-0.560***
	(-1.812)	(-9.238)	(-4.468)	(-2.687)	(-0.305)	(-4.601)
$\Delta(lnT)$	0.192	-0.006	0.011	-0.053	0.116***	0.141**
	(1.521)	(-0.148)	(0.403)	(-1.508)	(3.670)	(2.069)
$\Delta(lnF)$	0.060	0.062	-0.005	-0.038	0.010	-0.064
	(0.907)	(1.574)	(-0.152)	(-0.696)	(0.171)	(-1.129)
trend	-0.002**	-0.001*	0.000	0.001	0.001	0.000
	(-2.072)	(-1.715)	(0.894)	(1.441)	(1.357)	(0.287)
constant	0.067***	0.010	0.001	-0.010	-0.001	0.000
	(3.833)	(0.998)	(0.194)	(-1.058)	(-0.145)	(0.006)
F-statistic	4.317***	20.993***	8.777***	3.875***	11.486***	14.254***
R2-Adjusted	0.372	0.775	0.564	0.324	0.636	0.688
RSS	0.026	0.013	0.005	0.013	0.006	0.026
DW	2.001	1.324	1.698	2.06	1.453	1.911

Note: *, **, and *** denote 10%, 5% and 1% level of significance, respectively.
Student t-statistics are in parentheses.

3.3 Variance decomposition analysis

To complement our ARDL cointegration testing, a variance decomposition analysis is implemented to examine the effect of an innovation in the selected independent variables on economic growth. We apply the generalized impulse response approach developed by Pesaran and Shin (1998). This approach is suitable than the orthogonalized approach because it is invariant to the variables ordering in the VAR model. Moreover, according to Payne (2002) and Sari and Soytas (2007) the difference between both approaches is that in the orthogonalized decomposition the total of the variance decomposition for a variable will sum up to one while the generalized forecast error variance decomposition (GFEVD) approach accounts for the optimal proportion of each variable. The GFEVD is performed after the estimation of a vector autoregression (VAR) model and consists to decompose the forecast error variance of GDP into proportions attributed to shocks in all variables in the system including itself (Menyah and Wolde-Rufael, 2010). For Litterman (1979) the main weakness of the general VAR specification is that the number of free parameters increases quadratically with the number of variables in a system, and for even moderately-sized systems the model becomes highly over-parameterized relative to the number of available observations. Thus, considering the small sample size involved in this study, the number of variables and their additional lags, the estimated VAR model would have a small degree of freedom and a large mean square of out-of-sample forecast. To give thought to this problem, we use the Bayesian prior method to estimating a VAR model. According to Koop and Korobilis (2010) Bayesian VAR (BVAR) is a popular VAR to overcome over-parameterization problems. We

use the normal-Wishart prior which generalizes the Litterman prior by treating the error variance-covariance matrix as unknown matrix positive definite symmetric matrix rather than a fixed diagonal matrix (Karlsson, 2012). The Bayesian approach incorporates restrictions in the form of a prior distribution on the parameters (Karlsson, 2012).

This study focuses on the proportion of GDP per capita error variance due to the selected independence variables. We therefore present the result of forecast error variance decomposition with income per capita as the response variable and the impulse variables are investment per capita, energy efficiency, trade openness and financial development. The results are presented in Table 6. The results show that the forecast error variances of income per capita are essentially explained by innovations in investment per capita and energy efficiency. A shock on investment per capita explains income per capita error variation respectively by 17.94% in Botswana, 33.43% in Kenya, 47.84% in Senegal, 51.53% in South Africa and 48.32% in Togo. The variance decomposition for Cameroon reveals that investment per capita has a limited effect (0.02%) in explaining the error variation of the production. These findings support the ARDL and the short-term estimation results as we find no significant effect of investment per capita on income in Cameroon while it does in the rest of the sample. Moreover, the forecast error variance of energy efficiency explains about 11.11% of the forecast error variance of GDP per capita in Botswana, 51.59% in Cameroon, 41.31% in Kenya and 51.40% in Togo. In the contrast, the proportions are low for Senegal and South Africa both in the short-run (1 to 5 years) than the long-run (15 to 20 years). The finding of South Africa is noteworthy as we find no significant effect of energy efficiency in explaining the output. This could mean that energy issues are particularly critical for the other SSA countries than for South Africa. The forecast error variance of trade openness accounts substantially for the forecast error variance of income in Cameroon, South Africa and a little less in Togo. Furthermore, 9.87% of income per capita error variance in the short-term and up to 10.42% in the long-term is due to a shock on financial development in Senegal while it accounts for 36.59% in the long term in Togo.

4 Discussion

The determinants of economic growth have been the primary focus of theoretical and applied research over the last two decades (Shahbaz et al., 2008). Various factors have been identified in explaining long-run economic growth. A range of researchers has examined the impact of such factors on SSA growth. Kumar and Pacheco (2012) and Musila and Yiheyis (2015) for example explored the effect of trade openness on growth in Kenya and found mixed results as the first study found a positive effect of trade openness while the latter found the adverse effect. Adu et al. (2013) were concerned with the contribution of financial development to economic growth and also found an inconclusive result depending on financial indicator used. However,

Table 6: Results of the generalized forecast error variance decomposition of $\Delta(lny)$

Country	Horizon	$\Delta(lny)$	$\Delta(lnI)$	$\Delta(lnE)$	$\Delta(lnT)$	$\Delta(lnF)$
Botswana	1	100.0	17.94	11.11	3.17	0.00
	5	89.28	18.82	11.32	3.23	1.53
	10	89.28	18.82	11.32	3.23	1.53
	15	89.28	18.82	11.32	3.23	1.53
	20	89.28	18.82	11.32	3.23	1.53
Cameroon	1	100.0	0.02	51.59	11.68	1.44
	5	72.42	3.23	46.88	43.03	1.70
	10	72.40	3.23	46.87	43.04	1.70
	15	72.40	3.23	46.87	43.04	1.70
	20	72.40	3.23	46.87	43.04	1.70
Kenya	1	100.0	33.43	41.31	0.48	0.01
	5	84.44	44.02	33.99	3.07	4.61
	10	83.08	43.66	33.48	3.66	5.03
	15	82.71	43.88	33.30	3.78	5.20
	20	82.69	43.89	33.29	3.79	5.20
Senegal	1	100.0	47.84	1.80	2.24	9.87
	5	87.23	47.91	4.73	7.78	10.52
	10	86.22	48.30	4.77	7.78	10.43
	15	86.17	48.30	4.77	7.78	10.42
	20	86.17	48.30	4.77	7.78	10.42
South Africa	1	100.0	51.53	0.31	34.72	2.28
	5	83.72	67.09	4.32	25.94	2.60
	10	83.11	66.79	4.40	26.01	2.64
	15	83.10	66.79	4.40	26.02	2.64
	20	83.10	66.79	4.40	26.02	2.64
Togo	1	100.0	48.32	51.40	21.43	24.17
	5	76.69	57.39	42.90	14.85	36.84
	10	72.33	58.08	40.69	14.54	36.48
	15	72.07	58.20	40.60	14.45	36.59
	20	72.05	58.20	40.59	14.45	36.59

Note: The GFEVD computes the optimal proportion of the amount of forecast error variance decomposition for each variable. Unlike the orthogonalized decomposition, the row values do not sum up to 100.

prior works have focused essentially on individual effect using different methods and leading to inconclusive results. Furthermore, the role of certain factors has not been sufficiently studied. Hence, there remains a need of a multivariable approach that uses an efficient estimation method in examining the dynamics of long-run growth in SSA countries. This study investigates the impact of trade openness, energy efficiency and financial development on the long-run income per capita in six SSA countries namely Botswana, Cameroon, Kenya, Senegal, South Africa and Togo. To our knowledge, only Kumar et al. (2015) have this kind of purpose with some differences. We improve the study of Kumar et al. (2015) in four ways: Firstly, we use energy efficiency than total energy consumption as describes as well a technology innovation and is suitable to our specification; Secondly, we use a composite indicator of financial development rather than an unique financial development indicator; Thirdly, we consider dummy variables in the ARDL models to improve the quality of the F-test and take into account external shocks that occurred in SSA countries. The ARDL approach is suitable to test the effect of the selected factors on short-term and long-term growth; Finally, we carry out a GFEVD to examine the part of forecast error variance of income per capita explained by each variable.

The results show that in virtually all the countries studied, investment per capita and energy efficiency are essential in short-term output. This finding corroborates the neoclassical growth model view that investment in capital accumulation is the main determinant of growth in the short term. In the specific case of SSA countries, investment should also concerned the energy sector as regard to the lack access of energy and the high cost of production owing to energy. As for the long-term relationship, we find that investment per capita is positively associated to income per capita in Kenya and South Africa. These results are compatible with those of Kumar and Pacheco (2012) and Kumar et al. (2015) who found that investment in physical capital accumulation were the main determinant of growth respectively in Kenya and South Africa. In addition, the positive elasticity of trade openness is in line with that of Kumar et al. (2015) for South Africa although the coefficient is quite superior. However, the results contrast for energy and financial development owing to the indicators used to proxy these factors. We use energy use per GDP to account for energy efficiency and constructed a composite financial indicator in order to have a broad view of financial sector. Then, we find no significant effect of both factors on long-run growth in South Africa. However, the study proves that financial development is favorable to growth in Kenya while the opposite is observed in Togo. In the short-term, results suggest no significant effect of financial sector on the rate of change of income per capita. As mentioned earlier, only a small range of SSA population participates actively in the financial sector development. Additionally, the banking sector practices credit rationing and has a limited participation in funding private sector. This weak and/or missing links between financial sector and economic actors may explain the non-significant effect of financial development on production in the short-term and its negative effect in the long-term as observed in Togo. Most notably, this study indicates that energy is undeniably a vital factor in promoting long run

growth in SSA countries, especially in Togo. Brew-Hammond (2010) reported that SSA region compares poorly with others in the developing world in terms of the population relying on traditional biomass and in terms of access to electricity, whether electricity in the home or within given geographical area, averaged around 25% for the region. This lack access to energy induces high production costs so that a gain in energy needed to produce one unit increases more than proportionally the production per capita. Moreover, the inability of energy sector supply to meet the raising energy demand causes electrical generation shortfall and then production losses. With regard to energy as an important factor, the mobilization of domestic and external funding and the implementation of innovative policy are required to improve energy access and therefore economic growth in SSA countries (Brew-Hammond, 2010). For instance, World Bank (2006) indicated that the amount of investment needed to achieve 47% or 100% electrification (access of people to energy) by 2030 is estimated to US$ 4 billion or US$ 11 billion, respectively per year in SSA.

5 Conclusion

This study examined the effect of energy efficiency, international trade and financial development on long-run income per capita growth of six SSA countries. Since we used time series data, non-stationary properties were discussed using unit root tests with structural breaks. We performed an ARDL bound testing approach to check for both the short-term and the long-term effects. To complement our analysis, a GFEVD was applied to decompose the forecast variance of GDP per capita attributable to the selected independent variables. The results showed the existence of a long-run relationship between the variables in Kenya, South Africa and Togo. The short-term estimation pointed out the significant role of investment and energy in output process in virtually all the countries and the role of trade openness in South Africa and Togo. Based on the aforesaid outcomes, investment in capital accumulation and energy sector should be encouraged. Financial sector could contribute by enhancing access to financial services and financing more private sectors. The mobilization of external funding is also required. In view of SSA low rate of integration to foreign trade and its potential positive effect on growth, SSA countries should implement policy that promotes international trade and generates positive externalities due to external market and technology exchange. This study has focused on three factors and six SSA countries and the results are encouraging. However, a large amount of macroeconomic factors has not been extensively studied and the unavailability of sufficient data restrains the possible direction. Future work should deal with this issue and take a view of other determinants of SSA long-term growth.

6 References

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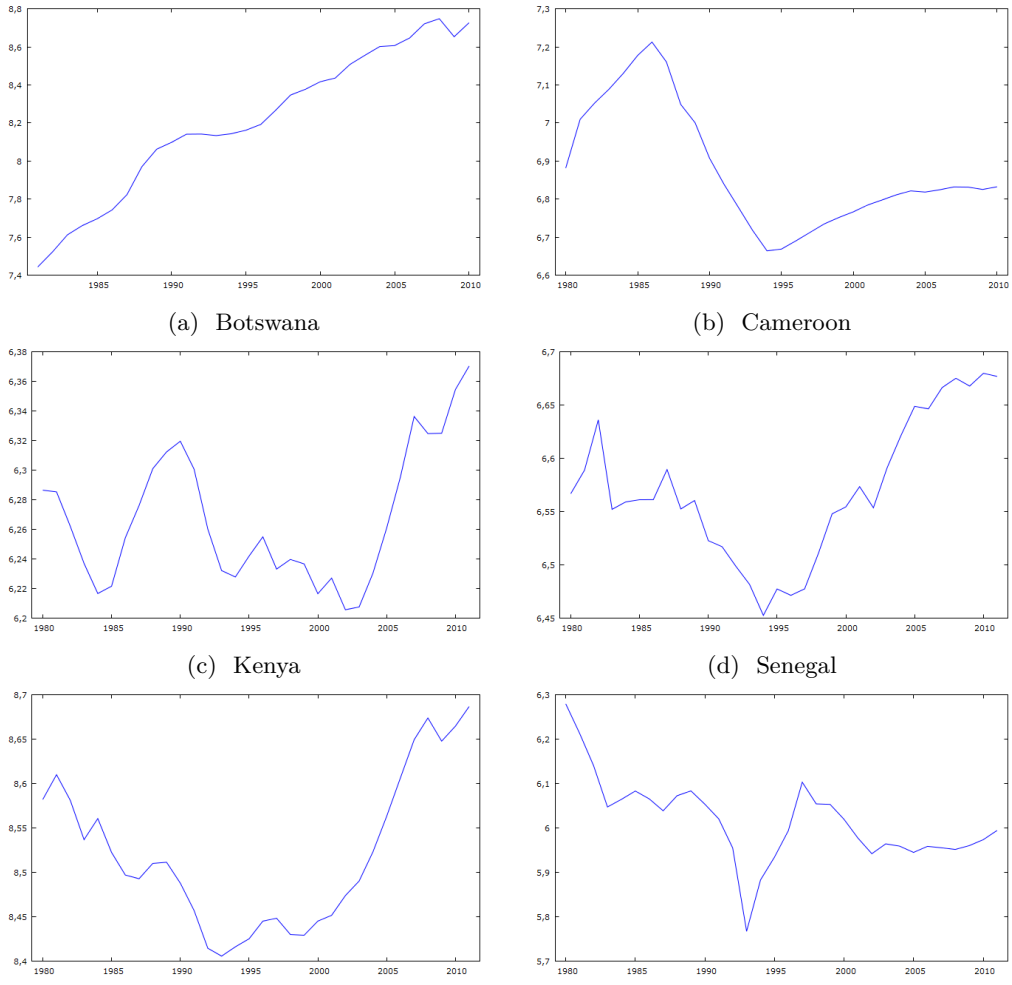
A Plots of real GDP per capita



(a) Botswana (b) Cameroon

(c) Kenya (d) Senegal

(e) South Africa (f) Togo

Figure 1: Time series plot of real GDP per capita (constant US$, logarithm value) in the selected countries

B Plots of CUSUM and CUSUMSQ tests for the parameter stability

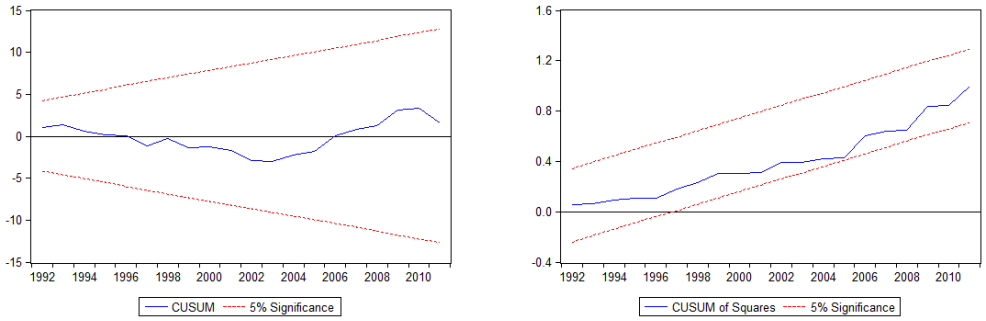


Figure 2: Kenya

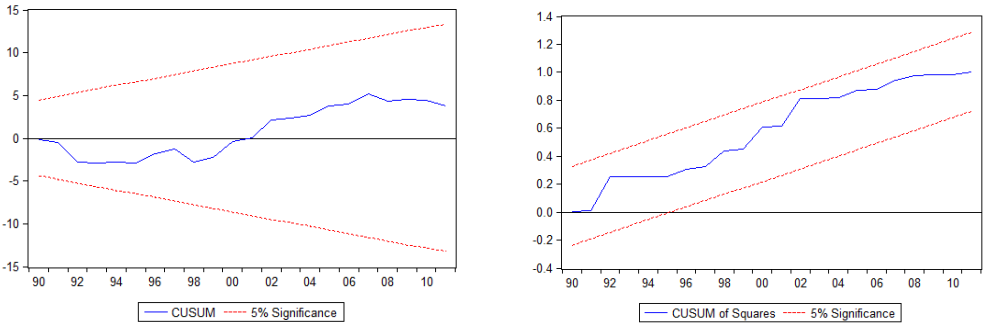


Figure 3: South Africa

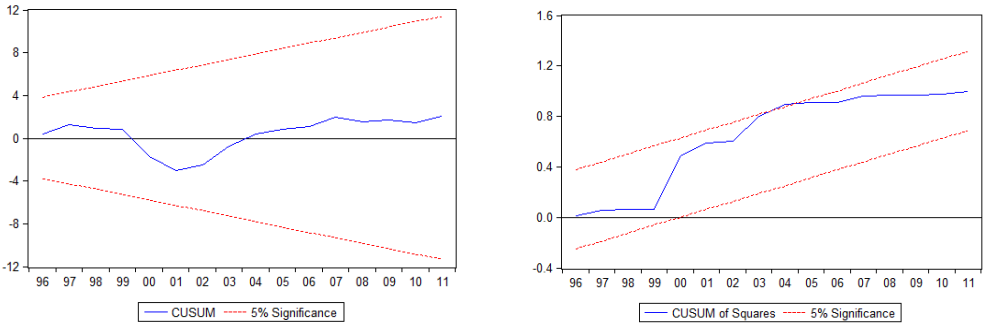


Figure 4: Togo